IEC 61158-4-17

Edition 1.0 2007-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 4-17: Data-link layer protocol specification – Type 17 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 4-17: Spécification de protocole de la couche de liaison de données – Eléments de Type 17

IEC 61158-4-17:2007

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,…).
Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC 61158-4-17

Edition 1.0 2007-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Industrial communication networks – Fieldbus specifications – Part 4-17: Data-link layer protocol specification – Type 17 elements

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 4-17: Spécification de protocole de la couche de liaison de données – Eléments de Type 17

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX V

ICS 25.040.40; 35.100.20

ISBN 978-2-8322-1021-5

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-17: Data-link layer protocol specification – Type 17 elements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

NOTE Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the IEC 61784 series. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

IEC draws attention to the fact that it is claimed that compliance with this standard may involve the use of patents as follows, where the [xx] notation indicates the holder of the patent right:

Type 17 and possibly other Types:

PCT Application No. PCT/JP2004/011537	[YEC]	Communication control method
PCT Application No. PCT/JP2004/011538	[YEC]	Communication control method

IEC takes no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained from:

[YEC]: Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, 180-8750 Tokyo,
180-8750 Tokyo,
Japan
Attention: Intellectual Property & Standardization Center

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61158-4-17 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This first edition and its companion parts of the IEC 61158-4 subseries cancel and replace IEC 61158-4:2003. This edition of this part constitutes a technical addition. This part and its Type 17 companion parts also cancel and replace IEC/PAS 62405, published in 2005.

This edition of IEC 61158-4 includes the following significant changes from the previous edition:

a) deletion of the former Type 6 fieldbus, and the placeholder for a Type 5 fieldbus data link layer, for lack of market relevance;

b) addition of new types of fieldbuses;

c) division of this part into multiple parts numbered -4-1, -4-2, ..., -4-19.

This bilingual version (2013-09) corresponds to the monolingual English version, published in 2007-12.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/474/FDIS	65C/485/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under http://webstore.iec.ch in the data related to the specific publication. At this date, the publication will be:

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

NOTE The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

The list of all the parts of the IEC 61158 series, under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

INTRODUCTION

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the "three-layer" fieldbus reference model described in IEC/TR 61158-1.

The data-link protocol provides the data-link service by making use of the services available from the physical layer. The primary aim of this standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer data-link entities (DLEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

a) as a guide for implementors and designers;

b) for use in the testing and procurement of equipment;

c) as part of an agreement for the admittance of systems into the open systems environment;

d) as a refinement to the understanding of time-critical communications within OSI.

This standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-17: Data-link layer protocol specification – Type 17 elements

1 Scope

1.1 General

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides communication opportunities to all participating data-link entities

a) in a cyclic asynchronous manner, sequentially to each of those data-link entities, and

b) in a synchronous manner, either cyclically or acyclically, according to a pre-established schedule.

The specified protocol also provides means of changing the set of participating data-link entities and of modifying the set of scheduled communications opportunities. When the set of scheduled communications opportunities is null, the distribution of communication opportunities to the participating data-link entities is completely asynchronous.

Thus this protocol can be characterized as one which provides access asynchronously but with a synchronous overlay.

1.2 Specifications

This standard specifies

a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;

b) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this standard, and their representation as physical interface data units.

1.3 Procedures

The procedures are defined in terms of

a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;

b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;

c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

1.5 Conformance

This standard also specifies conformance requirements for systems implementing these procedures. This standard does not contain tests to demonstrate compliance with such requirements.

2 Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For all other undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61158-3-17, *Industrial communication networks – Fieldbus specifications – Part 3-17: Data-link layer service definition – Type 17 elements*

ISO/IEC 7498 (all parts), *Information technology – Open Systems Interconnection – Basic Reference Model*

ISO/IEC 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks - Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

IEEE Std 802.3ab, *Information technology – Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements – Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications – Physical layer parameters and specifications for 1000 Mb/s operation over 4-pair of category 5 balanced copper cabling, type 1000BASE-T*

Internet Engineering Task Force (IETF), *Request for Comments (RFC):*

RFC 768 *User Datagram Protocol*
(available at <http://www.ietf.org/rfc/rfc0768.txt>)
RFC 791 *Internet Protocol*
(available at <http://www.ietf.org/rfc/rfc0791.txt>)
RFC 792 *Internet Control Message Protocol*
(available at <http://www.ietf.org/rfc/rfc0792.txt>)
RFC 826 *Ethernet Address Resolution Protocol*
(available at <http://www.ietf.org/rfc/rfc0826.txt>)
RFC 894 A standard for the Transmission of IP Datagrams over Ethernet Networks
(available at <http://www.ietf.org/rfc/rfc0894.txt>)
RFC 1112 *Host Extensions for IP Multicasting*
(available at <http://www.ietf.org/rfc/rfc1112.txt>)
RFC 2236 *Internet Group Management Protocol Version 2*
(available at <http://www.ietf.org/rfc/rfc2236.txt>)

3 Definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Terms and definitions

3.1.1 ISO/IEC 10731 terms

a) (N)-connection

b) (N)-entity

c) (N)-layer

d) (N)-service

e) (N)-service-access-point

f) confirm (primitive)

g) deliver (primitive)

h) indication (primitive)

i) request (primitive)

j) response (primitive)

3.1.2 Other terms and definitions

3.1.2.1
bridge
intermediate equipment that connects two or more segments using a Data Link layer relay function

3.1.2.2
domain
part of the RTE network consisting of one or two subnetwork(s)

NOTE Two subnetworks are required to compose a dual-redundant RTE network, and each end node in the domain is connected to both of the subnetworks.

3.1.2.3
domain master
station which performs diagnosis of routes to all other domains, distribution of network time to nodes inside the domain, acquisition of absolute time from the network time master and notification of status of the domain

3.1.2.4
domain number
numeric identifier which indicates a domain

3.1.2.5
external bridge
bridge to which neither internal bridges nor RTE stations are connected directly

3.1.2.6
interface port
physical connection point of an end node, which has an independent DL-address

3.1.2.7
internal bridge
bridge to which no routers, external bridges or nodes non-compliant with this specification are connected directly

3.1.2.8
junction bridge
bridge to which at least one router, external bridge or node non-compliant with this specification, and to which at least one internal bridge or RTE station is connected

3.1.2.9
link
physical communication channel between two nodes

3.1.2.10
network time master
station which distributes network time to domain masters

3.1.2.11
non-redundant interface node
node whch has a single interface port

3.1.2.12
non-redundant station
station that consists of a single end node

NOTE "non-redundant station" is synonymous with "end node".

3.1.2.13
path
logical communication channel between two nodes, which consists of one or two link(s)

3.1.2.14
redundant interface node
node with two interface ports one of which is connected to a primary network, while the other is connected to a secondary network

3.1.2.15
redundant station
station that consists of a pair of end nodes

NOTE Each end node of a redundant station has the same station number, but has a different DL-address.

3.1.2.16
route
logical communication channel between two communication end nodes

3.1.2.17
router
intermediate equipment that connects two or more subnetworks using a network layer relay function

3.1.2.18
RTE station
station with real-time capability

3.1.2.19
segment
communication channel that connects two nodes directly without intervening bridges

3.1.2.20
station
end node or a pair of end nodes that perform a specific application function

3.1.2.21
station number
numeric identifier which indicates a RTE station

3.1.2.22
subnetwork
part of a network that does not contain any routers. A subnetwork consists of end nodes, bridges and segments

NOTE Every end node included in a subnetwork has the same IP network address.

3.2 Abbreviations and symbols

3.2.1 ISO/IEC 10731 abbreviations

OSI Open Systems Interconnection

3.2.2 Other abbreviations and symbols

ASS acknowledged sequence of unitdata transfer service
AUS acknowledged unitdata transfer service
DL- Data-link layer (as a prefix)
DLE DL-entity (the local active instance of the data-link layer)
DLL DL-layer
DLM DL-management
DLMS DL-management Service
DLPDU DL-protocol-data-unit
DLS DL-service
DLSAP DL-service-access-point
DLSDU DL-service-data-unit
FIFO first-in first-out (queuing method)
ID identifier
IEC International Electrotechnical Commission
ind indication primitive
IP Internet protocol
ISO International Organization for Standardization
LLC logical link control
lsb least significant bit
MAC medium access control
msb most significant bit
MSS multipoint sequence of unitdata transfer service
MUS multipoint unitdata transfer service
PDU protocol data unit
Ph- physical layer (as a prefix)
PhL Ph-layer
QoS quality of service
req request primitive
rsp response primitive
SAP service access point
SDU service data unit
ToS type of dervice
UUS unacknowledged unitdata transfer service

3.3 Conventions

3.3.1 General conventions

This standard uses the descriptive conventions given in ISO/IEC 10731.

3.3.2 Conventions for DLE protocol procedure definitions

The conventions used for DLE state machine definitions are described in Table 1.

Table 1 – Conventions used for protocol procedure definitions

Event	Condition	Procedure
Events that trigger these actions	Conditions	Actions that are taken when the events and conditions are met

4 Overview of the DL-protocol

4.1 General

The Data Link Layer provides basic real-time and reliable communications between devices in automation environments.

This part of the document specifies

a) procedures of the Data Link (DL) protocols for real-time data transfer and control information from one Data Link Service user entity to a peer user entity, and among the Data Link entities forming the distributed Data Link Service provider;

b) the structure of the Data Link Protocol Data Units (DLPDUs) used for data transfer and control information, and their mapping to the underlying layers.

The procedures are defined in terms of

a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus Data Link Protocol Data Units;

b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;

c) the interactions between a DLS-provider and a Physical Service provider in the same system through the exchange of Ph-service primitives.

4.2 Characteristics of the protocol

The requirements of continuous process control, e.g. in the Oil and Gas, Petrochemical and Chemical, Pharmaceutical and Power industries, result in the following characteristic features of the Data Link protocol.

The maximum system size for this protocol is 254 subnetworks of 254 nodes, where each node has 254 DLSAP-addresses. All Data Link entities can communicate with all others in a cyclic or acyclic manner with prioritized access, or in a combination of the two.

This protocol provides real-time communication by means of transmission scheduling. The minimum cycle-time of scheduling is 10 ms. In addition, it provides a means to maintain clock synchronization across a subnetwork with a precision better than 1 ms, and across an extended network with a precision better than 5 ms.

This protocol provides reliable and flexible communications by remotely confirmed acyclic data transfer with retransmission. In addition, it provides a dual-redundant network with a switchover time of less than 100 ms, and also provides the facilities for dual-redundant devices.

4.3 Data-link layer architecture

4.3.1 General

The DLL is modeled as

a) a real-time data transfer function;

b) a datagram transfer function;

c) a network routing function;

d) a media access function;

e) a logical link and management function.

With the exception of the real-time data transfer function, each function is implemented according to the following existing protocols specified in Table 2.

Table 2 – Referenced standards for the layers

Function	Compliance
Datagram transfer function	RFC 768 (UDP)
Network routing function	RFC 791 (IP)
Media access function	ISO/IEC 8802-3, IEEE Std 802.3ab

4.3.2 Real-time data transfer function

The real-time data transfer function is specified in this specification, and it provides the Connectionless-mode Data Link Service specified in IEC 61158-3-17.

4.3.3 Datagram transfer function

The datagram transfer function is compliant with RFC 768 (UDP definition) and provides datagram transfer service for the real-time data transfer function.

4.3.4 Network routing function

The network routing function is compliant with RFC 791 (IP definition) and provides datagram routing service for the datagram transfer function.

This function also performs fragmentation of a datagram to maintain independence from MTU of the underlying sublayer. The function utilizes two logical link functions to realize a dual-redundant network.

In a dual-redundant station, two network routing entities are implemented for both end nodes.

4.3.5 Logical link and media access function

The logical link and media access function is compliant with ISO/IEC 8802-3. It provides fragments transfer service within a subnetwork and a means of accessing the network for the network routing function.

Two entities that execute media access function are implemented in a node to realize a dual-redundant network.

4.3.6 Management function

The management function is specified in this specification, and it provides the DL-management Service and DLSAP management Data Link Service. These services are specified in IEC 61158-3-17.